Revised New Grade 8 Science Standards

Revision by Michael A. Clarke Ph.D. and Terry Hufford Ph.D. of the rearticulated standards adopted by the State Board of Education,
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Grade 8 Science: Preamble

Scientific Thinking and Inquiry, Structure of Matter, Reactions, Density and Buoyancy, Conservation of Energy, Electricity and Magnetism, Forces, and Waves remain the fundamental principles of this rearticulation.

Scientific progress is made by asking relevant questions, conducting careful investigations, and drawing appropriate inferences based on observations and evidence. As a basis for understanding this concept, and to address the content in this grade, students should develop their own questions, perform investigations, and suggest appropriate inferences based on those investigations.

As part of the scientific process, students should explain why accuracy and openness in record keeping and replication are essential for maintaining an investigator's credibility with other scientists and society and participate in group discussions on specific topics.

Other activities should be encouraged to develop a sound understanding and interpretation of content.

Students should be exposed to:

- **a)** The work of pioneers of physics and cosmology, such as Nicolaus Copernicus, Galileo Galilei, Johannes Kepler, Isaac Newton, Hans Christian Oersted and Andre-Marie Ampère, Dmitry Ivanovich Mendeleyev, Albert Einstein, and Lise Meitner.
- **b)** The contributions of the scientists involved with the development of current atomic theory, including John Dalton, Marie and Pierre Curie, Joseph John Thomson, Albert Einstein, Max Planck, Ernest Rutherford, Niels Bohr, Antoine Lavoisier, and Erwin Schroedinger.

Students should investigate:

- **a)** How during endothermic chemical reactions heat energy is absorbed from the surroundings, and in exothermic reactions heat energy is released to the surroundings.
- **b)** That reactions occur at different rates, slow to fast, and that reaction rates can be changed by changing the concentration of reactants, the temperature, the surface areas of solids, and by using a catalyst.
- **c)** That equal volumes of different substances usually have different masses and, therefore, different densities.
- **d)** How kinetic energy can be transformed into potential energy, and vice versa (e.g., in a bouncing ball.

e) That heat energy is a common product of an energy transformation, such as in biological growth, the operation of machines, the operation of a light bulb, and the motion of people.

f) That in processes at the scale of atomic size or greater, energy cannot be created or destroyed but only changed from one form into another.

g) That an object can be electrically charged either positively or negatively; objects with like charges repel each other, or objects with unlike charges attract each other.

h) How sound in a fluid (e.g., air) is a longitudinal wave whose speed depends on the properties of the fluid in which it propagates.

i) How light waves, sound waves, and other waves move at different speeds in different materials.

Students should discover:

a) How elements and compounds (reactants) react with each other forming products with different properties

Grade 8

Strand 1	**Scientific Thinking and inquiry**
Standard 1 Scientific Process	Students at this level should be honing their skills in the Scientific Process. Students should be able to:
	8.1. 1. Describe how scientific knowledge is subject to modification and refinement as new information challenges prevailing theories. **8.1. 2.** Test hypotheses that pertain to the content under study. **8.1. 3.** Restate or summarize accurately what others have said, asking for clarification or elaboration, and expressing alternative positions based on available evidence [emphasizing the importance of evidence over opinion for scientific reasoning]. **8.1. 4.** Identify and criticize: (a) Reasoning in arguments for which fact and opinion are intermingled (b) Conclusions that do not follow logically from the evidence given, (c) Analogies that are not apt (d) Control groups that are insufficiently characterized both for their similarity and dissimilarity with the experimental group.
Standard 2 Experimental Design	Students at this level should be honing their skills in Experimental Design. Students should be able to:
	8.2.1. Describe how changes in more than one variable at the same time in an experiment influence the ability to attribute that outcome to a change in any single variable. **8.2.2.** Write clear step-by-step instructions (procedural summaries) for conducting investigations. **8.2.3.** Use tables, charts, and graphs in making arguments and claims in presentations about lab work and describe what can be inferred from the graphs and illustrations. **8.2.4.** Read analog and digital meters on instruments used to make direct measurements of length, volume, weight, elapsed time, rates, or temperatures, and choose appropriate units. Explain how to interpolate on analog scales. **8.2.5.** Explain why arguments may be invalid if based on very small samples of data, biased samples, or experiments in which there was no control sample.
Strand 2	**Matter and Reactions**
Standard 3 Structure of Matter	Students at this level will be refining their understandings around concepts of Structure of Matter. Students should be able to:
	8.3. 1. Explain that all matter is made up of atoms that are far too small to see directly through an optical microscope. **8.3. 2.** Construct a model of an atom showing the atom is composed of protons, neutrons, and electrons. No knowledge of other subatomic particles is required at this grade level. **8.3.3.** Explain that an object can be neutral (e.g., atom) or electrically charged (e.g., ion) having either a positive or negative charge. **8.3.4.** Demonstrate that objects with like charges repel each other and objects with unlike charges attract each other. **8.3.5.** Know that atoms of the same element may have different mass numbers and may be characterized as being different isotopes of that element.

	8.3.6. Know that density is mass per unit volume. **8.3.7.** Explain that equal volumes of different substances usually have different masses and, therefore, different densities. **8.3.8.** Determine the density of substances (regular and irregular solids, and liquids) from direct measurements of mass and volume, or of volume by water displacement.
Standard 4 Classification and the Periodic Table	Students should begin to understand the importance of Classification in science and should be exposed to using the primary classification tool of Chemistry, the Periodic Table. Students should be able to:
	8.4.1. Using a periodic chart, infer that the atoms of any element are similar in structure to each other, having the same number of protons [Atomic Number] but they are different from atoms of other elements. Know that the atoms of the same isotope are identical to each other. **8.4.2.** Describe how elements can be classified, based on similar properties, into categories, including highly reactive metals, less reactive metals, highly reactive nonmetals, less reactive nonmetals, and some almost completely non-reactive (noble) gases.
Standard 5 Bonding	Students should be developing concepts around the nature of chemical Bonding and its impact on physical properties of matter. Students should be able to:
	8.5.1. Diagram and describe how atoms may combine (bond) into molecules or into large crystalline arrays. **8.5.2.** Know that there are more than 100 elements that combine in a multitude of ways producing compounds that make up all the living and nonliving things in the universe. **8.5.3.** Know and describe how these elements may combine by sharing electrons (covalent bonding) or as a result of the transfer of electrons (ionic bonding). Students should be able to give examples of each type of bonding.
Standard 6 Kinetic Theory of Matter	Students will be able to relate the Kinetic Theory of Matter to the structure and behavior of matter. Specifically Students should be able to:
	8.6.1. Describe how the atoms, molecules, or ions comprising an object are in constant individual motion, and explain how their average motional (kinetic) energy determines the temperature of the object, and how the strength of the forces between them determines the state of matter at that temperature. **8.6.2.** Explain that the melting and boiling temperatures of a substance (element or compound) depend on pressure and are independent of the amount of the sample. (Some materials do not melt and others do not boil because they decompose as the temperature is raised; other materials do not have a sharp melting point because they are not homogeneous.)
Standard 7 Conservation of Mass	Students will be introduced to the Law of Conservation of Mass and its application to understanding chemical and physical changes. Specifically Students should be able to:
	8.7.1. Describe Law of Conservation of Matter, using the idea that when materials react with each other, many changes can take place, but that in every case the total amount of matter afterward is the same as before. **8.7.2.** Explain how the idea of atoms explains the conservation of matter: In chemical reactions, the number of atoms stays the same no matter how they are arranged, and the mass of atoms does not change significantly in

	chemical reactions, so their total mass stays the same.
Standard 8 Chemical Reactions	Students will be introduced to concepts of Chemical Reactions. This includes concepts of reactions at the atomic level and the observable level. Students will also be introduced to indicators and measures of reactants and reactions. Specifically Students should be able to:
	8.8.1. Explain how elements and compounds (reactants) react with each other forming products with different properties. **8.8.2.** Explain how during endothermic chemical reactions heat energy is absorbed from the surroundings, and in exothermic reactions heat energy is released to the surroundings. **8.8.3.** Explain that reactions occur at different rates, slow to fast, and that reaction rates can be changed by changing the concentration of reactants, the temperature, the surface areas of solids, and by using a catalyst. **8.8.4.** Recognize that solutions can be acidic, basic, or neutral, depending on the concentration of hydrogen ions in the solution. Understand that because this concentration can vary over a very large range, the logarithmic pH scale is used to describe how acidic or basic a solution is (each increase of one in the pH scale is an increase of 10 times in concentration). **8.8.5.** Recognize that indicators of chemical changes include temperature change, the production of a gas, the production of a precipitate, or a color change.
Standard 9 Electricity and Magnetism	Students will begin to make concepts of Electricity and Magnetism operational. Specifically Students should be able to:
	8.9.1. Explain that when an electric current flows there is always a magnetic field associated with it. **8.9.2.** Describe the role that electromagnets play in electric motors, electric generators, and simple devices such as doorbells and earphones. **8.9.3.** Explain how electrical circuits provide a means of transferring electrical energy from sources such as generators to devices in which heat, light, sound, and chemical changes are produced.
Strand 3	**Forces:**
Standard 10 Special Forces	Students will be introduced to the phenomena of Special Forces (gravitation, weight, and buoyancy) including how these forces are measured and manipulated. Specifically Students should be able to:
	8.10.1. Explain that every object exerts an attractive gravitational force on every other object. **8.10.2.** Demonstrate that the mass of an object is a measure of the quantity of matter it contains (measured in kg or g), and that its weight (measured in N) is the magnitude of the gravitational force exerted between Earth and that much mass. **8.10.3.** Determine and explain that the buoyant force on an object in a fluid is an upward force equal to the weight of the fluid the object has displaced; this principle can be used to predict whether an object will float or sink in a given fluid.
Standard 11 Forces and Motion	Students will be introduced to the relationship between Forces and Motion. Students will also explore the mathematical relationships between Forces and Motion as well as the graphical representation of these relationships. Specifically Students should be able to:
	8.11. 1. Recognize that a force has both magnitude and direction. **8.11. 2.** Observe and explain that when the forces on an object are balanced (equal and opposite forces that add up to zero), the motion of the

	object does not change. **8.11. 3.** Explain why an unbalanced force acting on an object changes the object's speed or direction of motion or both. **8.11.4.** Know that the greater the mass of an object, the more force is needed to change its motion. **8.11.5.** Apply simple mathematical models to problems (e.g., formulas such as *F = ma, d = st*). **8.11. 6.** Explain that if the net force acting on an object always acts toward the same center as the object moves, the object's path is a curve about the force center. (Motion in a circular orbit is the simplest example of this concept.) **8.11. 7.** Plot and interpret distance versus time graphs for constant speed.
Strand 4	**Energy and Waves**
Standard 12 Forms of Energy	Students will increase their knowledge and understanding of Sources and Forms of Energy and how they are inter-related. . Specifically Students should be able to:
	8.12. 1. Explain, based on their understanding, how energy is the ability to do work and is measured in joules (J). **8.12. 2.** Describe kinetic energy as the energy of motion (e.g., a rolling ball), and potential energy as the energy of position or configuration (e.g., a raised object or a compressed spring). **8.12.3.** Recognize and describe that energy is a property of many systems and can take the form of mechanical motion, gravitational energy, the energy of electrostatic and magnetostatic fields, sound, heat, and light (electromagnetic field energy). **8.12.4.** Describe that energy may be stored as potential energy in many ways, including chemical bonds and in the nucleus of atoms. **8.12.5.** Explain that the sun emits energy in the form of light and other radiation, and only a tiny fraction of that energy is intercepted by the Earth. **8.12.6.** Know that the sun's radiation consists of a wide range of wavelengths; mainly visible light, infrared, and ultraviolet radiation.
Standard 13 Types of Waves	Students will be introduced to Types of Waves, mechanical and electromagnet. Specifically Students should be able to:
	8.13.1. Explain how a mechanical wave is a disturbance that propagates through a medium. **8.13.2.** Explain how electromagnetic waves differ from mechanical waves in that they do not need a medium for propagation; nevertheless, they can be described by many of the same quantities: amplitude, wavelength, frequency (or period), and wave speed. **8.13.3.** Recognize that human eyes respond to a narrow range of wavelengths of the electromagnetic spectrum (red through violet) called *visible light.* **8.13.4.** Summarize how something can be "seen" when light waves emitted or reflected by an object enter the eye, just as something can be "heard" when sound waves from an object enter the ear.
Standard 14 Wave Properties	Students will be introduced to the analysis and description of Wave Properties especially properties related to propagation and energy descriptors. Specifically Students should be able to:
	8.14. 1. Observe and explain how waves carry energy from one place to another. **8.14.2.** Explain how sound in a fluid (e.g., air) is a longitudinal wave whose speed depends on the properties of the fluid in which it propagates. **8.14.3.** Explain how light waves, sound waves, and other waves move at different speeds in different materials.

	8.14.4. Demonstrate that vibrations in materials set up wave disturbances, such as sound and earthquake waves, which spread away from the source. **8.14.5.** Explain that waves obey the superposition principle: Many waves can pass through the same point at once, and the wave amplitude at that point is the sum of the amplitudes of the individual waves.
Standard 15 Energy Transfer and Transformation	Students will be introduced to the analysis and description of Energy Transfer and Transformation. Specifically Students should be able to:
	8.15.1. Explain how kinetic energy can be transformed into potential energy, and vice versa (e.g., in a bouncing ball). **8.15.2.** Explain that heat energy is a common product of an energy transformation, such as in biological growth, the operation of machines, the operation of a light bulb, and the motion of people. **8.15.3.** Explain how electrical energy can be generated using a variety of energy sources and can be transformed into almost any other form of energy, such as mechanical motion, light, sound, or heat. **8.15.4.** Compare and contrast how heat energy can be transferred through radiation, convection, or conduction. **8.15. 5.** Know that power is energy per unit of time, expressed in watts, W, and 1 W = 1 J/s. Explain that devices are rated according to their power capacity or consumption
Standard 16 Conservation of Energy	Students will be introduced to the Law of Conservation of Energy. Specifically Students should be able to:
	8.16.1. Explain that in processes at the scale of atomic size or greater, energy cannot be created or destroyed but only changed from one form into another.